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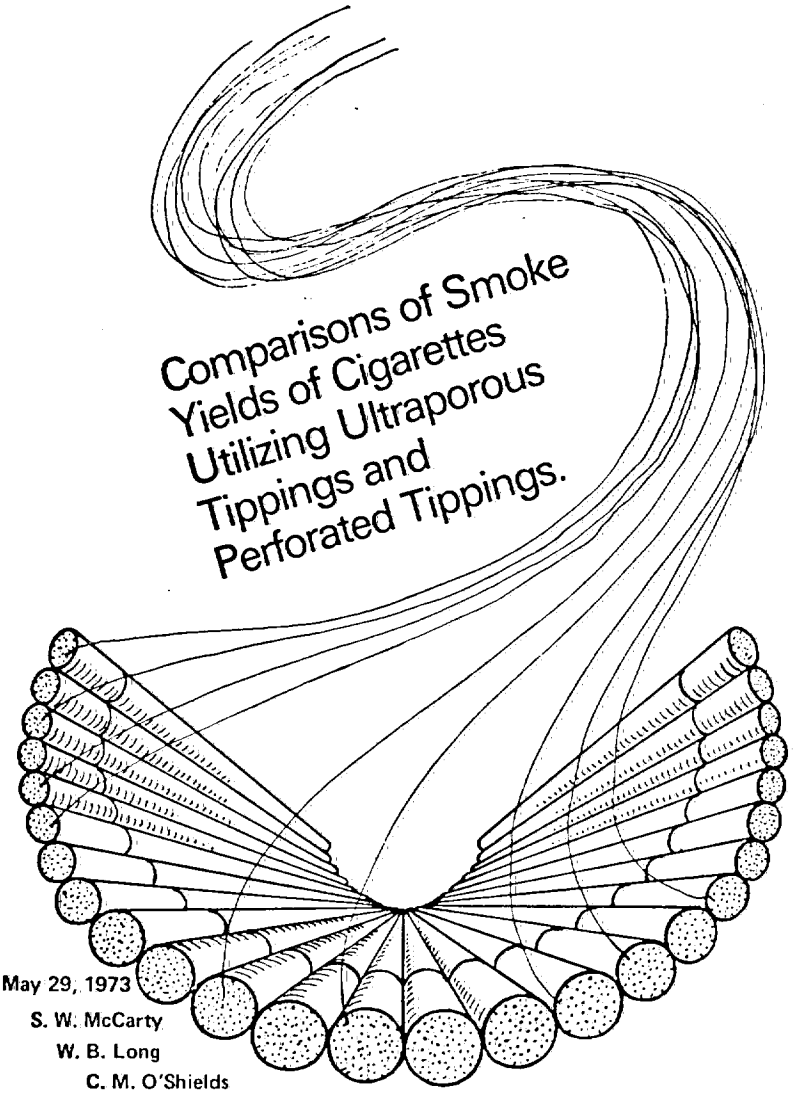

Comparisons of Smoke Yields of Cigarettes Utilizing Ultraporous Tippings and Perforated Tippings.

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S. W. McCarty
W. B. Long
C. M. O'Shields

ECUSTA PAPER DIVISION Olin
P.O. BOX 200, PISGAH FOREST, NORTH CAROLINA 28768

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COMPARISONS OF SMOKE YIELDS OF CIGARETTES UTILIZING ULTRAPOROUS TIPPINGS AND PERFORATED TIPPINGS

S. W. McCARTY, W. B. LONG, AND C. M. O'SHIELDS

Technical Department, Ecusta Paper Division
Olin Corporation
Pisgah Forest, North Carolina

INTRODUCTION

In recent years air dilution around the filter tips of cigarettes has become a popular and widely-used method of reducing the smoke yield from cigarettes. The prevalent way of accomplishing this air dilution effect has been through the use of perforated tippings which are products having discrete holes through which air is pulled to dilute the mainstream smoke. With the recent development of Ecusta's ultraporous tipping paper, an additional way to effect air dilution is possible, in that the air can be pulled through the porous tipping without obvious, discrete holes being visible.

The purpose of this present study has been to investigate under controlled laboratory conditions the smoke yields from cigarettes utilizing various combinations of ultraporous tippings and porous plug wraps and to compare these smoke yields with those obtained from cigarettes using perforated tippings as a means of air dilution.

EXPERIMENTAL

Tobacco columns made from a typical commercial tobacco blend were cut to 75 mm lengths for this study and conditioned at 72°F, 62% R. H. for 24 hours. These tobacco columns were then tipped with 25 mm filters, made from 4.2 dpf/40,000 td cellulose acetate tow, having a pressure drop with nonporous plug wrap of 2.1 inches of water/25 mm.

Ecusta ultraporous tippings, perforated tippings, and porous plug wraps were used to prepare the filter rods and finished cigarettes. Control cigarettes were prepared using ultraporous and perforated tippings in conjunction with nonporous Type A plug wrap which was determined to give no air dilution effect.

The cigarettes were tipped leaving various unglued widths, 5 mm, 10 mm or 15 mm, centered 12.5 mm from the mouth end of the cigarette as shown in Figure 1.

The cigarettes were smoked to within 5 mm of the tipping (65 mm smoked), and the smoke yields were determined by standard FTC procedures.

DISCUSSION

The porosity data for the various porous plug wraps and ultraporous tippings are given in Table I. Smoke yields and related data are given in Tables II-IV and depicted graphically in Figures 2-7.

As evidenced by the tables and graphs, the tar yields from cigarettes utilizing ultraporous tippings decrease as (1) the tipping paper becomes more porous, (2) the plug wrap becomes more porous, or (3) the unglued area of the tipping is increased. Nicotine, although not shown graphically, follows the same trend as can be seen from Tables II-IV. The tar and nicotine yields are fairly well related to the cigarette pressure drop.

Smoke yield reductions of up to 75% were achieved in this study. The unglued areas of the tippings were not unreasonably large for normal cigarette production and could probably be used commercially without undue difficulty. It is obvious that a wide range of smoke yield reductions can be achieved with the proper selection of porous plug wrap and ultraporous tipping.

Of obvious interest in this study is the comparison of the effects on smoke yields of ultraporous tippings and perforated tippings since these materials are both used to achieve air dilution at the cigarette filter tip. The smoke yields obtained using one-line, three-line, and six-line perforated tippings are given in Table V and shown graphically in Figures 8 and 9.

It can be seen from comparing these data for perforated and ultraporous tippings that comparable smoke yields can be obtained by either approach with the appropriate selection of tipping and plug wrap. For example, tar yield reductions of approximately 20% were obtained by:

(1) 3-line perforated tipping / Type C plug wrap,

(2) ultraporous tipping #1 (10 mm unglued area) / Type C plug wrap, or

(3) ultraporous tipping #3 (10 mm unglued area) / Type B plug wrap.

For one further example, an approximate 50% tar reduction was obtained by:

(1) 6-line perforated tipping / Type D plug wrap,

(2) ultraporous tipping #2 (15 mm unglued area) / Type E perforated plug wrap, or

(3) ultraporous tipping #3 (10 mm unglued area) / Type D plug wrap.

In other words, a large range of smoke yield reductions is possible with either perforated tippings or ultraporous tippings with the appropriate selection of porous plug wraps.

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CONCLUSION

Smoke yields from cigarettes utilizing ultraporous tippings have been measured and found to be comparable to those obtained from commonly used perforated tippings. A wide range of tar and nicotine reductions was obtained (5%-75%) with the appropriate selection of ultraporous tipping, unglued porous area and porous plug wrap.

TABLE I

POROSITY DATA FOR TIPPING PAPERS AND PLUG WRAPS USED IN THIS STUDY

Paper Identification	Porosity (Inches / 50 cc / sec)*
Ultraporous Tipping No. 1	12.7
Ultraporous Tipping No. 2	4.6
Ultraporous Tipping No. 3	1.6
One-Line Perforated Tipping	8.2
Three-Line Perforated Tipping	1.2
Six-Line Perforated Tipping	0.4
Type A Nonporous Plug Wrap	Nonporous
Type B Porous Plug Wrap	8.2
Type C Porous Plug Wrap	3.1
Type D Porous Plug Wrap	1.2
Type E Perforated Plug Wrap	0.1

* These porosity values were obtained by measuring the pressure drop in inches of water across a single thickness of the paper associated with passing a constant air flow of 50 cc / sec through a 5 cm^2 area of the paper.

TABLE II

SMOKE YIELDS – ULTRAPOROUS TIPPING NO. 1*

Plug Wrap	Unglued Width (mm)	Cigarette Pressure Drop (in. H_2O)	No. Puffs (per cig.)	Wet TPM (mg/cig.)	Water (mg/cig.)	Dry TPM (mg/cig.)	Nicotine (mg/cig.)	Tar (mg/cig.)	Tar Reduction by Air Dilution (%/cig.)	Tar (mg/puff)
Type A	5	3.7	10.3	23.3	2.9	20.4	1.4	19.0	-	1.84
Type A	10	3.6	10.5	22.9	2.4	20.5	1.4	19.1	-	1.82
Type A	15	3.8	10.3	23.1	2.5	20.6	1.4	19.2	-	1.86
Type B	5	3.6	10.7	21.9	3.3	18.6	1.3	17.3	9	1.62
Type B	10	3.2	10.8	19.4	2.7	16.7	1.3	15.4	19	1.43
Type B	15	3.1	11.3	17.5	1.8	15.7	1.2	14.5	24	1.28
Type C	5	3.5	10.5	20.2	1.9	18.3	1.3	17.0	11	1.62
Type C	10	3.3	10.7	18.5	2.0	16.5	1.3	15.2	20	1.42
Type C	15	3.0	11.6	16.9	1.7	15.2	1.2	14.0	27	1.21
Type D	5	3.3	10.9	17.1	1.3	15.8	1.3	14.5	24	1.33
Type D	10	3.1	11.2	16.2	1.4	14.8	1.2	13.6	29	1.21
Type D	15	2.8	11.3	14.0	0.6	13.4	1.1	12.3	36	1.09
Type E	5	3.3	11.0	16.6	1.0	15.6	1.3	14.3	25	1.30
Type E	10	3.0	11.7	16.0	1.2	14.8	1.2	13.6	29	1.16
Type E	15	2.7	11.7	14.1	0.8	13.3	1.1	12.2	36	1.04

*Average Porosity = 12.7 inches / 50 cc / sec

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TABLE III

SMOKE YIELDS – ULTRAPOROUS TIPPING NO. 2 *

Plug Wrap	Unglued Width (mm)	Cigarette Pressure Drop (in. H_2O)	No. Puffs (per cig.)	Wet TPM (mg/cig.)	Water (mg/cig.)	Dry TPM (mg/cig.)	Nicotine (mg/cig.)	Tar (mg/cig.)	Tar Reduction by Air Dilution (%/cig.)	Tar (mg/puff)
Type A	5	3.8	10.7	24.9	3.2	21.7	1.5	20.2	-	1.90
Type A	10	3.7	9.8	22.9	2.6	20.3	1.4	18.9	-	1.93
Type A	15	3.8	9.8	23.8	2.5	21.3	1.4	19.9	-	2.03
Type B	5	3.5	10.3	21.9	2.2	19.7	1.4	18.3	7	1.78
Type B	10	3.1	10.7	18.6	1.5	17.1	1.2	15.9	19	1.49
Type B	15	2.8	10.8	17.5	2.7	14.8	1.1	13.7	30	1.27
Type C	5	3.2	10.8	19.7	2.0	17.7	1.2	16.5	16	1.53
Type C	10	2.8	10.9	18.0	1.2	16.8	1.1	15.7	20	1.44
Type C	15	2.6	11.3	15.9	1.4	14.5	1.0	13.5	31	1.19
Type D	5	3.1	10.9	18.4	1.4	17.0	1.1	15.9	19	1.46
Type D	10	2.7	11.4	16.5	1.0	15.5	1.0	14.5	26	1.27
Type D	15	2.4	11.4	13.8	0.4	13.4	0.9	12.5	37	1.10
Type E	5	3.2	10.7	18.7	2.2	16.5	1.1	15.4	22	1.44
Type E	10	2.5	11.3	15.7	0.9	14.8	1.0	13.8	30	1.18
Type E	15	2.1	11.7	11.9	0.3	11.6	0.8	10.8	45	0.92

*Average Porosity = 4.6 inches / 50 cc / sec

TABLE IV

SMOKE YIELDS – ULTRAPOROUS TIPPING NO. 3 *

Plug Wrap	Unglued Width (mm)	Cigarette Pressure Drop (in. H_2O)	No. Puffs (per cig.)	Wet TPM (mg/cig.)	Water (mg/cig.)	Dry TPM (mg/cig.)	Nicotine (mg/cig.)	Tar (mg/cig.)	Tar Reduction by Air Dilution (%/cig.)	Tar (mg/puff)
Type A	5	4.0	10.6	23.9	3.5	20.4	1.5	18.9	-	1.78
Type A	10	3.9	10.7	25.0	3.7	21.3	1.6	19.7	-	1.84
Type A	15	4.0	10.7	22.5	2.5	20.0	1.4	18.6	-	1.74
Type B	5	3.3	10.6	20.2	1.8	18.4	1.3	17.1	10	1.61
Type B	10	3.0	11.1	18.1	2.0	16.1	1.2	14.9	22	1.34
Type B	15	2.8	11.0	16.3	1.3	15.0	1.1	13.9	27	1.26
Type C	5	2.9	10.7	18.9	1.6	17.3	1.3	16.0	16	1.50
Type C	10	2.7	11.1	16.5	1.5	15.0	1.2	13.8	28	1.24
Type C	15	2.3	11.4	13.9	0.7	13.2	0.8	12.4	35	1.09
Type D	5	2.8	11.4	16.6	1.5	15.1	1.2	13.9	27	1.22
Type D	10	2.2	11.7	12.6	1.4	11.2	1.0	10.2	47	0.87
Type D	15	1.8	12.2	8.0	0.6	7.4	0.7	6.7	65	0.55
Type E	5	2.3	11.7	13.4	1.2	12.2	1.0	11.2	41	0.96
Type E	10	1.9	12.7	9.3	0.6	8.7	0.8	7.9	59	0.62
Type E	15	1.5	12.7	5.1	0	5.1	0.4	4.7	75	0.37

* Average porosity = 1.6 inches / 50 cc / sec.

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TABLE V

SMOKE YIELDS – PERFORATED TIPPING

Plug Wrap	Lines of Perforations	Cigarette Pressure Drop (in.H_2O)	No. Puffs (per cig.)	Wet TPM (mg/cig.)	Water (mg/cig.)	Dry TPM (mg/cig.)	Nicotine (mg/cig.)	Tar (mg/cig.)	Tar Reduction by Air Dilution (%/cig.)	Tar (mg/puff)
Type A	1	4.0	11.2	24.8	3.0	21.8	1.3	20.5	-	1.83
Type A	3	4.0	11.0	24.3	3.0	21.3	1.3	20.0	-	1.81
Type A	6	4.0	10.9	25.3	3.3	22.0	1.4	20.6	-	1.89
Type B	1	3.7	11.2	20.4	1.4	19.0	1.2	17.8	13	1.59
Type B	3	3.4	11.9	20.1	1.7	18.4	1.1	17.3	15	1.45
Type B	6	3.2	12.0	18.1	0.9	17.2	1.0	16.2	21	1.35
Type C	1	3.7	11.7	20.4	1.9	18.5	1.2	17.3	15	1.48
Type C	3	3.2	11.9	18.7	1.9	16.8	1.1	15.7	23	1.32
Type C	6	2.8	12.4	15.4	1.0	14.4	0.9	13.5	34	1.09
Type D	1	3.2	12.0	17.5	1.4	16.1	1.0	15.1	26	1.26
Type D	3	2.6	12.4	13.4	0.3	13.1	0.8	12.3	40	0.99
Type D	6	2.4	12.1	10.9	0.5	10.4	0.7	9.7	52	0.80
Type E	1	3.1	12.0	15.5	1.0	14.5	1.0	13.5	34	1.13
Type E	3	2.2	13.2	8.7	0.2	8.5	0.6	7.9	61	0.60
Type E	6	1.8	14.3	4.3	0.3	4.0	0.3	3.7	82	0.26

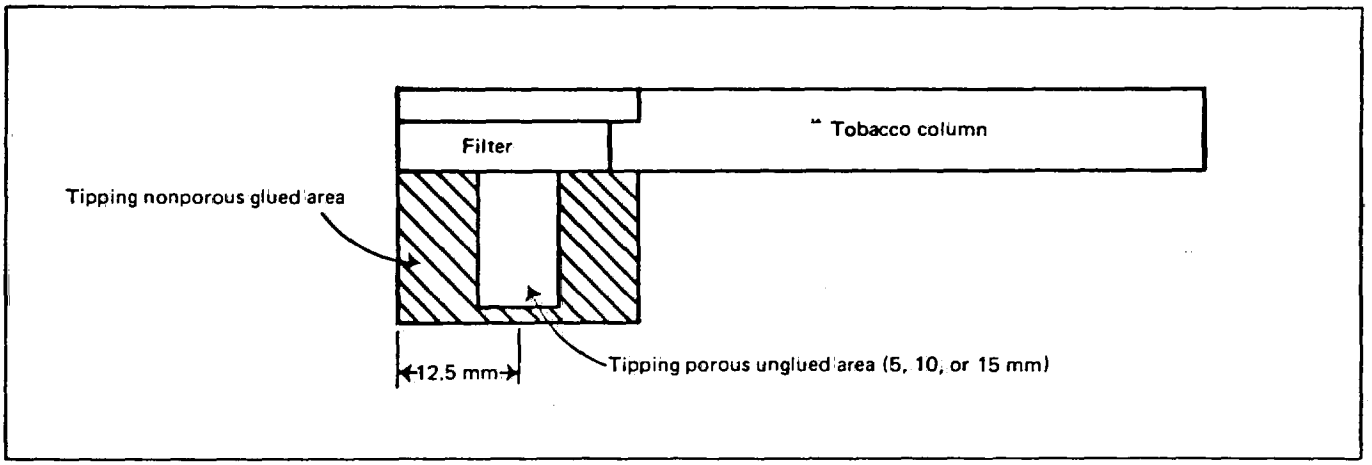

FIGURE 1 DIAGRAM OF EXPERIMENTAL CIGARETTE UTILIZING ULTRAPOROUS TIPPING

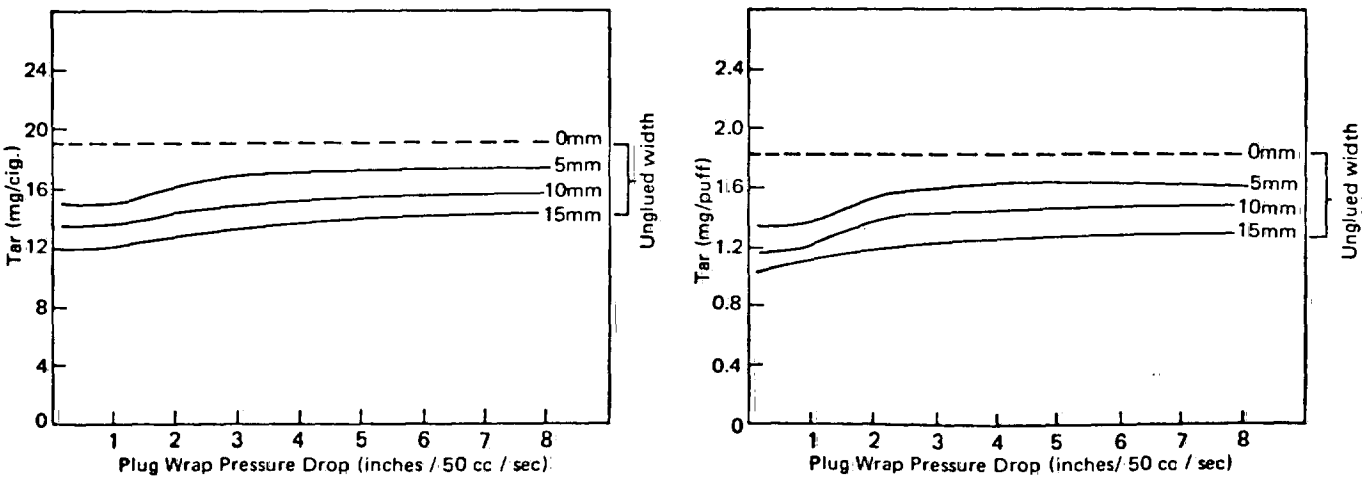

FIGURE 2 SMOKE YIELD AS A FUNCTION OF PLUG WRAP POROSITY FOR ULTRAPOROUS TIPPING NO. 1

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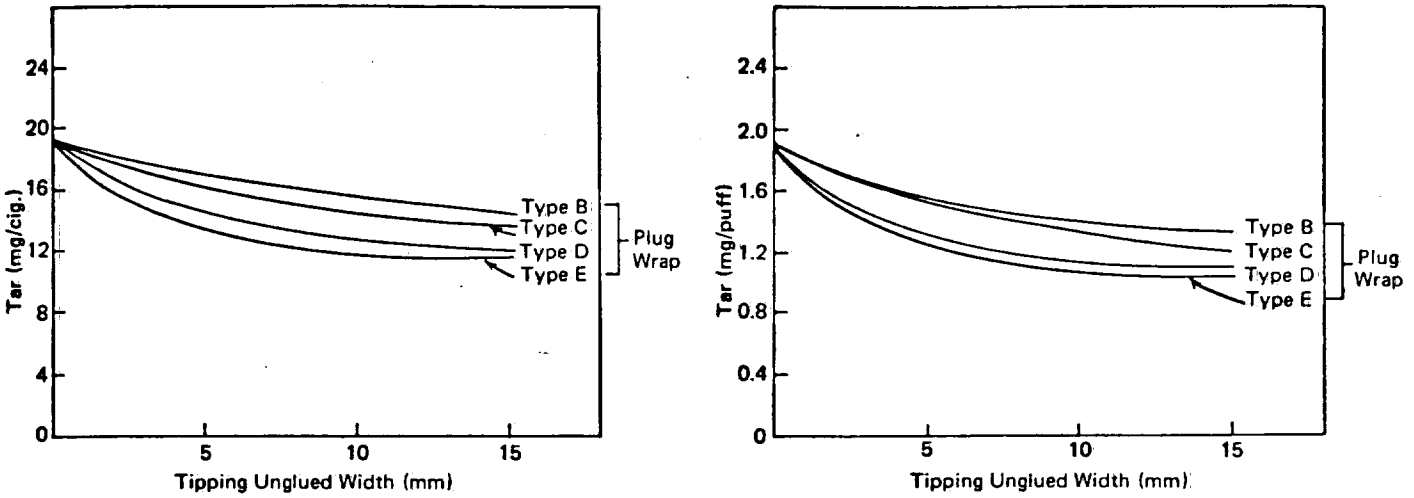

FIGURE 3 SMOKE YIELD AS A FUNCTION OF THE UNGLUED WIDTH FOR ULTRAPOROUS TIPPING NO. 1

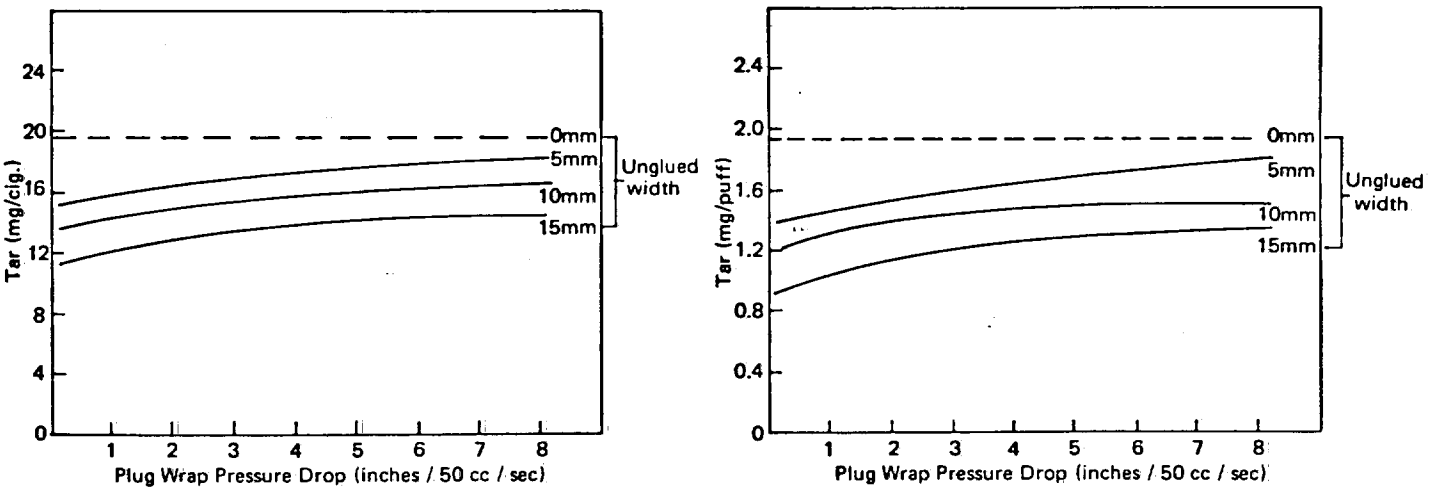

FIGURE 4 SMOKE YIELD AS A FUNCTION OF PLUG WRAP POROSITY FOR ULTRAPOROUS TIPPING NO. 2

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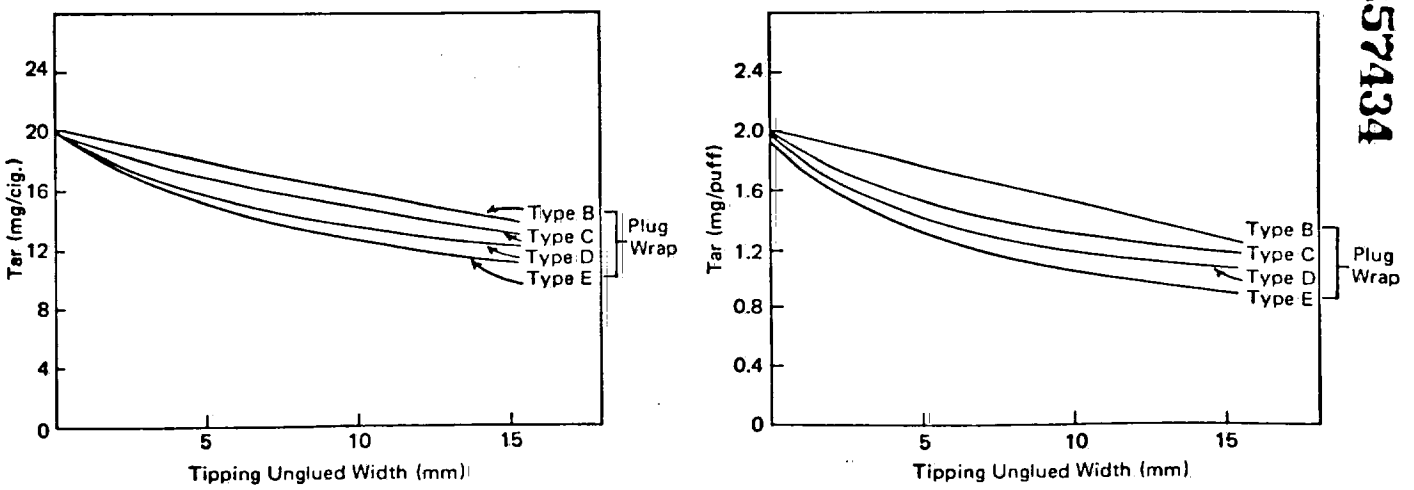

FIGURE 5 SMOKE YIELD AS A FUNCTION OF THE UNGLUED WIDTH FOR ULTRAPOROUS TIPPING NO. 2

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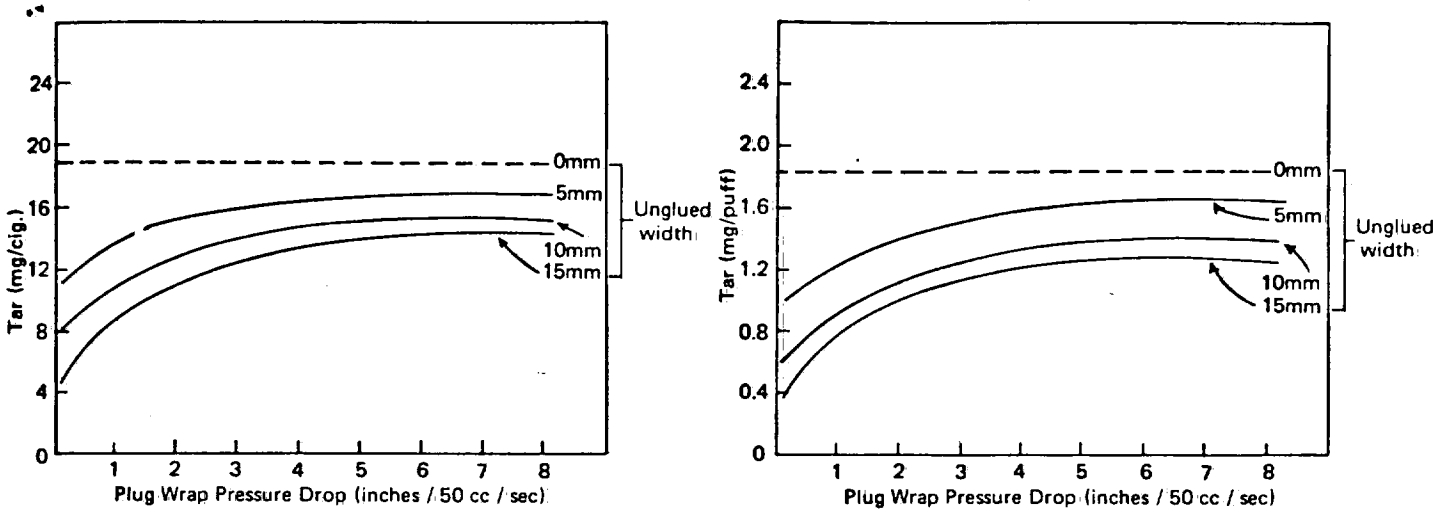

FIGURE 6 SMOKE YIELD AS A FUNCTION OF PLUG WRAP POROSITY FOR ULTRAPOROUS TIPPING NO. 3

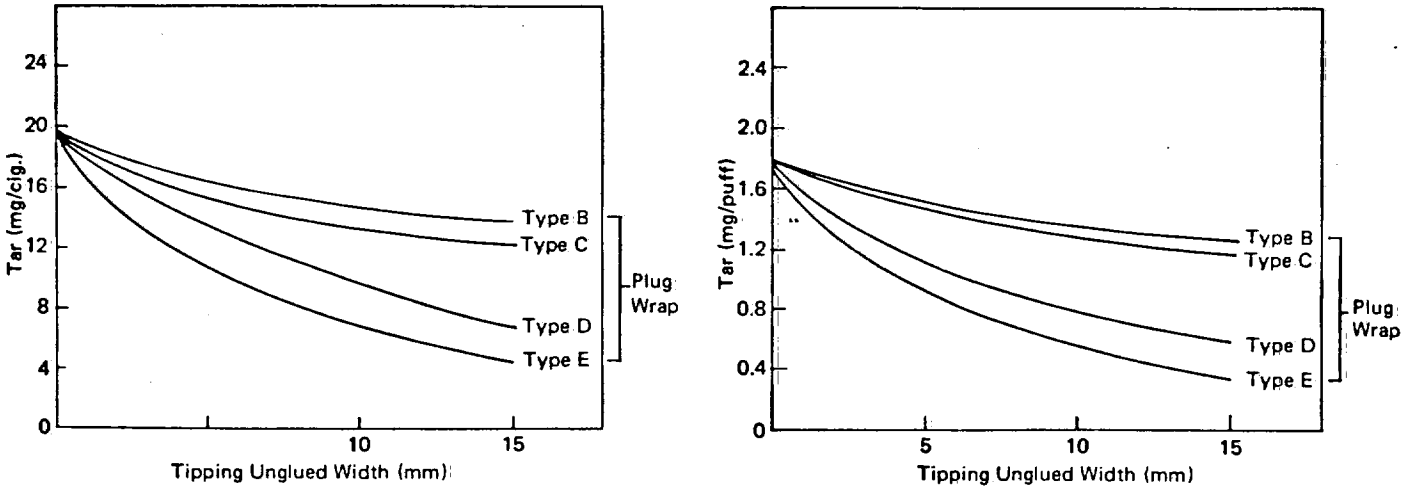

FIGURE 7 SMOKE YIELD AS A FUNCTION OF THE UNGLUED WIDTH FOR ULTRAPOROUS TIPPING NO. 3

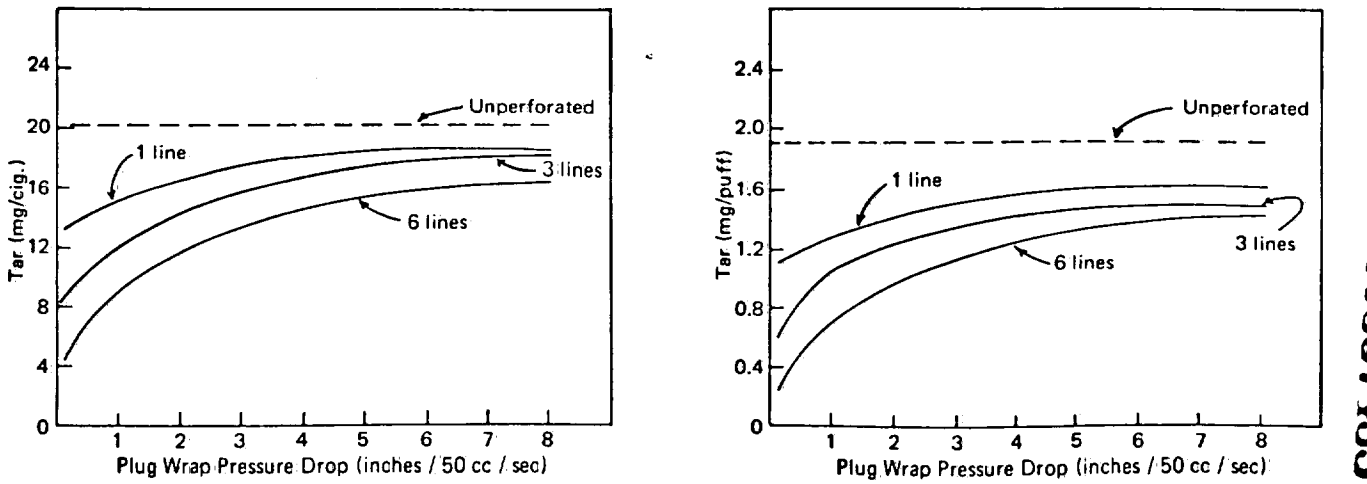

FIGURE 8 SMOKE YIELDS AS A FUNCTION OF PLUG WRAP POROSITY FOR PERFORATED TIPPING

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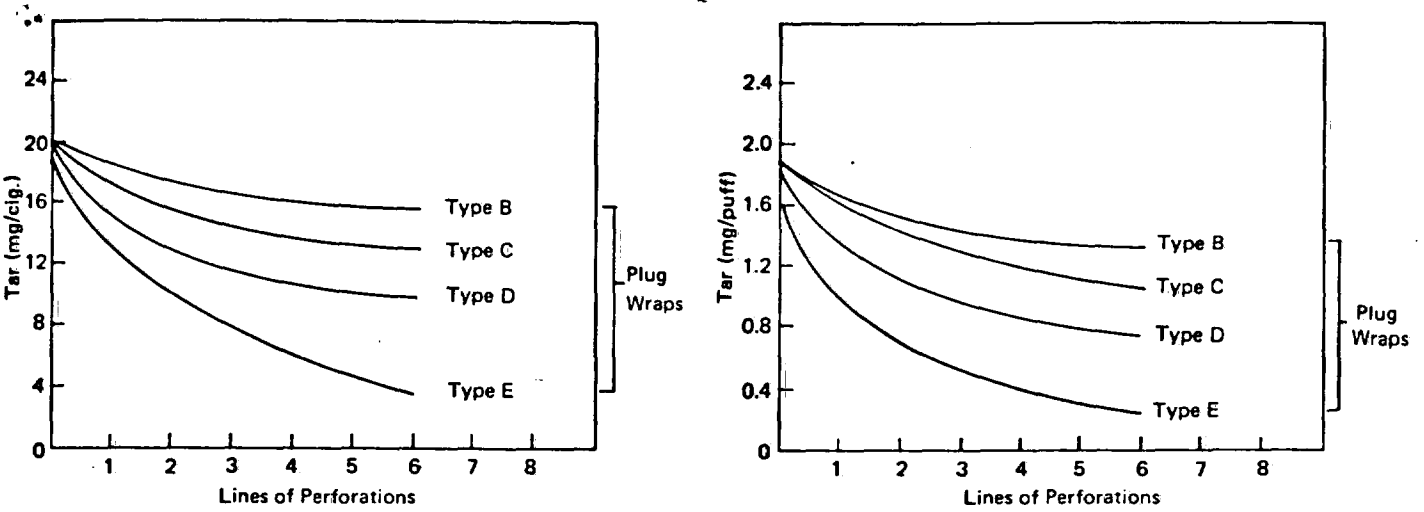

FIGURE 9 SMOKE YIELDS AS A FUNCTION OF NUMBER OF PERFORATED TIPPING LINES

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